

What is claimed is:

BEST AVAILABLE COPY

1  
2  
3  
4  
5  
6  
7  
8

1. An optical spectrometer component comprising:  
a fiber optic input;  
collimating optics disposed between the fiber optic input and  
a linear variable filter having  
an etalon structure with  
a tapered spacer region being tapered along a taper direction,  
the linear variable filter being affixed to  
a linear optical detector array disposed along the taper direction.

1  
2

2. The optical spectrometer of claim 1 wherein the collimating optics  
comprise a magnifying lens and a collimating lens.

1  
2  
3  
4  
5  
6  
7  
8

3. The optical spectrometer of claim 1 wherein the linear variable filter  
has  
a first reflector comprising a first plurality of high-index layers and a first  
plurality of  $\text{SiO}_2$  layers, the first plurality of high-index layers alternating with the first  
plurality of  $\text{SiO}_2$  layers; and  
a second reflector comprising a second plurality of high-index layers and a  
second plurality of  $\text{SiO}_2$  layers, the second plurality of high-index layers alternating with  
the second plurality of  $\text{SiO}_2$  layers wherein the tapered spacer region comprises  $\text{SiO}_2$ .

1  
2

4. The optical spectrometer of claim 3 wherein at least some layers of  
the first plurality of high-index layers comprise  $\text{Ta}_2\text{O}_5$ .

1  
2

5. The optical spectrometer of claim 3 wherein at least some layers of  
the first plurality of high-index layers comprise  $\text{Nb}_2\text{O}_5$ .

1  
2  
3

6. The optical spectrometer of claim 1 wherein the linear variable filter  
has a thermal stability of less than 50 parts per million per degree Centigrade of ambient  
temperature change.

1  
2  
3

7. The optical spectrometer of claim 1 wherein the linear variable filter  
has a thermal stability of less than 25 parts per million per degree Centigrade of ambient  
temperature change.

1 8. The optical spectrometer of claim 1 wherein the linear variable filter  
2 has a thermal stability of less than 10 parts per million per degree Centigrade of ambient  
3 temperature change.

1 9. The optical spectrometer of claim 1 wherein the linear variable filter  
2 is a bandpass filter.

1 10. The optical spectrometer of claim 1 wherein the linear variable filter  
2 is a band-edge filter.

1 11. An optical spectrometer component comprising:  
2 a fiber optic input;  
3 a magnifying lens disposed to expand an optical signal from the fiber optic  
4 input to  
5 a collimating lens, the collimating lens disposed to provide a light beam to  
6 a linear variable bandpass filter having  
7 an etalon structure with  
8 a tapered spacer region being tapered along a taper direction,  
9 the linear variable filter having a thermal stability of less than or equal to 50 parts per  
10 million per degree Centigrade of ambient temperature change; and  
11 a linear optical detector array disposed along the taper direction.

1 12. The optical spectrometer of claim 11 wherein the optical detector  
2 array has a length along the taper direction of less than or equal to 12 mm.

1 13. The optical spectrometer of claim 11 wherein the linear variable  
2 bandpass filter has a 50% bandwidth of less than or equal to about 0.6 nm at a center  
3 wavelength, the center wavelength being between about 1530-1600 nm.

1 14. An optical spectrometer component comprising:  
2 a fiber optic input;  
3 a magnifying lens disposed to expand an optical signal from the fiber optic  
4 input to  
5 a collimating lens, the collimating lens disposed to provide a light beam to  
6 a linear variable bandpass filter having  
7 an etalon structure with

8 a tapered spacer region being tapered along a taper direction,  
9 the linear variable filter having a thermal stability of less than or equal to 50 parts per  
10 million per degree Centigrade of ambient temperature change and a 50% bandwidth of less  
11 than or equal to about 0.6 nm at a center wavelength, the center wavelength being between  
12 about 1530-1600 nm; and

13 a linear optical detector array disposed along the taper direction, the linear  
14 optical detector array having a length of less than or equal to 12 mm along the taper  
15 direction.

15. The optical spectrometer component of claim 14 wherein the linear  
2 optical detector array has at least 256 pixels.

16. The optical spectrometer component of claim 14 wherein the linear  
2 optical detector array has at least about 512 pixels so as to provide a nominal resolution of  
3 the optical spectrometer component of about 3 Angstroms or less.

17. A method of measuring an optical signal with an optical  
2 spectrometer, the method comprising:  
3 calibrating an optical spectrometer component having a linear variable filter  
4 with an etalon structure including at least one tapered spacer region and a detector array  
5 having at least  $n$  detectors by  
6 providing at least  $3n$  calibration signals at  $3n$  calibration  
7 wavelengths to the optical spectrometer component;  
8 measuring an output from each of the  $n$  detectors in response to each of the  
9 calibration signals with an analyzer;  
10 storing the output from each of the  $n$  detectors at each of the calibration  
11 signals to create a calibration array;  
12 providing an optical input signal to the optical spectrometer component;  
13 measuring a second output from each of the  $n$  detectors; and  
14 reconstructing the optical input signal using the calibration array in an  
15 inverse transfer process to produce a reconstructed input signal.

18. The method of claim 17 wherein the optical spectrometer  
2 component has a nominal resolution of  $X$  nm and the reconstructed input signal has an  
3 equivalent resolution of better than  $X/5$  nm.

1 19. The method of claim 17 wherein the optical spectrometer  
2 component has a nominal resolution of less than or equal to 8 Angstroms, and the  
3 calibration wavelengths are at intervals of about 0.5 Angstroms or less.

1 20. The method of claim 19 wherein the reconstructed output signal has  
2 an effective resolution of less than about 1.6 Angstroms.

1 21. The method of claim 17 wherein the optical spectrometer  
2 component comprises a detector array having at least 512 pixels and has a nominal  
3 resolution of less than or equal to 3 Angstroms over an operating band of between about  
4 1530-1600 nm.

1 22. A method of measuring an optical signal with an optical  
2 spectrometer, the method comprising:  
3 calibrating an optical spectrometer component having a linear variable filter  
4 with an etalon structure including at least one tapered spacer region and a detector array  
5 having at least  $n$  detectors to provide a nominal resolution of less than or equal to 8  
6 Angstroms across an operating band of the optical spectrometer component, the operating  
7 band lying within about 1530-1600 nm, by  
8 providing a plurality of calibration signals to the optical  
9 spectrometer component throughout the operating band at intervals of about 0.5  
10 Angstroms;

11 measuring an output from each of the  $n$  detectors in response to each of the  
12 calibration signals with an analyzer;

13 storing the output from each of the  $n$  detectors at each of the calibration  
14 signals to create a calibration array;

15 providing an optical input signal to the optical spectrometer component;

16 measuring a second output from each of the  $n$  detectors; and

17 reconstructing the optical input signal using the calibration array in an  
18 inverse transfer process to produce a reconstructed input signal having an effective  
19 resolution of less than 1.6 Angstroms.

1 23. A method of monitoring an optical network, the method  
2 comprising:

3 calibrating an optical spectrometer having an optical detector with  $n$   
4 detectors and a nominal resolution of  $X$  nm at at least  $3n$  calibration wavelengths;  
5 providing a plurality of optical signals on an optical transmission line;  
6 coupling at least a portion of at least some of the plurality of optical signals  
7 to the optical spectrometer;  
8 measuring the at least some of the plurality of optical signals with the  
9 optical spectrometer;  
10 reconstructing the at least some of the plurality of optical signals using a  
11 transfer function to provide reconstructed signals having an effective resolution of at least  
12  $X/5$  nm.

1 24. The method of claim 23 wherein the monitoring of the optical  
2 network is a continuous monitoring of the optical network.

1 25. The method of claim 23 wherein the plurality of optical signals  
2 carried on the optical network are wavelength-division-multiplexed optical signals having  
3 a nominal channel spacing of less than or equal to about 200 GHz.

5 26. A optical transmission network comprising:  
an input optical fiber configured to carry a plurality of wavelength-  
division-multiplexed optical signals having nominal channel spacing of about 200 GHz or  
less;

an output optical fiber;  
an optical tap disposed between the input optical fiber and the output  
10 optical fiber and configured to couple a portion of at least some of the plurality of  
wavelength-division-multiplexed optical signals to  
an optical spectrometer component having  
a linear variable filter including an etalon structure with at least one  
tapered spacer region being tapered along a taper direction, and  
15 a detector array affixed to the linear variable filter; and  
an analyzer coupled to the optical spectrometer component so as to monitor each of the  
some of the plurality of optical signals.

add a2